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(54) VENTED MOLD AND USE THEREOF

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Description**TECHNICAL FIELD**

The present invention relates to a novel mold for producing foamed articles. Specifically, an aspect of the present invention relates to an improved mold including a vent capable of providing necessary venting of the mold while minimizing extrusion of raw material into the vent, thus reducing wastage. In its most preferred embodiment, the present invention also eliminates the requirement to remove the extruded raw material from the molded article prior to application of a finish (e.g. trim) cover.

The present invention also relates to a novel method of molding articles which reduces wastage resulting from raw material being extruded into the vent during venting of the mold. In its most preferred embodiment, the method reduces or eliminates the requirement to remove the extruded material prior to application of a finish cover.

BACKGROUND ART

Many articles are manufactured by placing a raw material into a cavity in a mold wherein the raw material undergoes a physical change (e.g. it expands or foams) and the article produced thus acquires the shape of the cavity. In particular, this technique is commonly employed for producing foamed articles made from polymeric foams such as polyurethane foam, latex (e.g. natural and styrene-butadiene rubber) foam and the like.

For example, automotive seats are commonly manufactured from polyurethane cushions which are molded to shape and then covered with a vinyl, cloth or leather finish cover. Polyurethane foams are somewhat unique in that foaming and at least a portion of the polymerization process occur simultaneously. Thus, in the production of polyurethane foam using, for example, a conventional cold foam technique, a typical formulation comprises:

1. Polyol
2. Water
3. Tetramethyl ethane diamine
4. Dimethyl ethanol amine
5. Polyisocyanate

The mixture is dispensed into a mold using a suitable mixing head, after which the mold is then closed to permit the expanding mass within it to be molded. Accordingly, it is convenient generally to refer to the mixture initially dispensed into the mold as "a liquid foamable polymeric composition" or, in this case, "a liquid foamable polyurethane composition". As the composition expands in the mold, polymerization occurs and the polymer so formed becomes solidified.

When molding a liquid foamable polymeric compo-

sition to form articles such as polyurethane foam articles, it is conventional to use a clam-shell mold comprising a bottom mold and a top mold which, when closed, define a mold cavity. The mold is opened, the liquid foamable polyurethane composition is dispensed into the mold cavity and the mold is closed as a chemical reaction causes the composition to expand. After the mold is closed, the composition expands to fill the interior cavity of the mold. Alternatively, the composition may be dispersed into a closed mold. In either case, as the polymerization reaction is completed, the foam cures and permanently assumes the shape of the mold cavity.

As is known to those of skill in the art, it is essential during this process that the mold be adequately vented to allow the air present in the mold to exit the mold as the foamable composition expands. Further, it is essential to allow a portion of the gases (typically CO₂ in the production of polyurethane) generated during polymerization to exit the mold.

Failure to adequately vent the mold results in defective molded articles exhibiting symptoms of improper foaming such as surface hardening (or foam densification) and/or void formation in the finished article due to trapped gas or air bubbles. At the other extreme, excess venting of the mold will also result in defective molded articles due to collapse of the foam prior to curing; this phenomenon is often referred to as the 'soufflé' effect. Thus, proper venting of molds is an important factor in producing acceptable molded articles.

Typically clam-shell molds are designed with drilled or cut passages in the top mold to provide vents. Locating, sizing and deciding upon the number of these vents is a matter of some skill on the part of mold designer and the production engineers, and is often an iterative procedure with more vents being added to various locations or other vents being blocked-off after test runs have been made.

During molding operations some liquid foamable polymeric composition which moves into the vent is wasted. It is generally desired to minimize the amount of wasted material (also known as "flash", "mushrooms", "buds", "pancakes" and the like) for two reasons, namely (1) the wasted material adds to the overall expense of producing the finished article, and (2) the wasted material must be removed from the molded article prior to the finish cover being applied, thereby necessitating additional labour and the costs associated therewith.

Accordingly, mold designers and production engineers are continually striving to optimize the compromise between providing enough venting at the proper locations while avoiding excess venting and minimizing material wastage during venting.

DE-A-2,246,948 teaches a mold for producing foamed articles wherein the walls of the mold are designed to include a plurality of countersunk plastic plugs. The plastic plugs are used once only and include a plurality of small diameter openings which are

intended to permit gas to pass therethrough while preventing the entry of the foaming material. This approach is disadvantageous since it requires incorporation of a plurality of "single-use" plugs which increases the overall cost of production of the foam article. Further, the small diameter openings in the plastic plugs are readily susceptible to blockage by the foaming material leading to inadequate venting of all gases which increases the likelihood of production of defective mold articles discussed above.

US-A-4,191,722 teaches a mold for producing a composite synthetic resin foam roofing structure wherein the top of the mold comprises a vent screw (see element 70 in Figures 3, 10 and 11) having a small vent hole "to vent trapped air, not synthetic foam" (column 6, lines 41-42). Indeed, it is taught that the small vent hole serves to prevent venting of the foam with the result that the foam can be packed to a greater density (column 6, lines 43-45). This approach is disadvantageous since the small vent hole in the vent screw is readily susceptible to blockage by the foaming material leading to inadequate venting of all gases which increases the likelihood of production of defective mold articles discussed above.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a novel method of producing a molded article which obviates or mitigates material wastage during venting.

It is another object of the present invention to provide a novel mold which obviates or mitigates at least some of the above-mentioned problems with prior art.

It is yet another object of the present invention to provide a novel method of producing a molded article from which vent-extruded material need not be removed.

According to a first aspect of the present invention, there is provided a method of producing an article in a mold comprising an upper mold and a lower mold defining a mold cavity, the process comprising the steps of:

- dispensing a liquid foamable polymeric composition into the mold cavity;
- allowing the liquid foamable polymeric composition to expand to substantially fill the mold cavity; and
- venting gases in the mold cavity through at least one vent in the mold to allow the gases to exit from the mold, the size of each vent being selected such that movement of the liquid foamable polymeric composition into the vent is restricted to substantially prevent exit thereof from the vent.

Preferably, the at least one vent is located at the part-line of the mold and comprises a thickness in the range from about 0.050 mm (0.002 inches) to about 0.765 mm (0.030 inches), more preferably in the range from about 0.125 mm (0.005 inches) to about 0.510 mm (0.020 inches).

Also preferably, the at least one vent is rectangular in cross-section and the polymeric material which enters the vent forms a ribbon of material on said article which need not be removed when a finish cover is applied to said article.

According to a second aspect of the present invention, there is provided a mold for producing foamed articles, the mold comprising:

- 10 an upper mold and a lower mold which define a mold cavity; and
- 15 at least one vent in communication with the mold cavity, the size of each vent being selected to allow relatively free flow of gases therethrough and to restrict movement of a liquid foam polymeric composition therethrough.
- 20 Preferably, the vent includes first and second vents, the first vent being located at the part-line between the top and bottom molds.
- 25 In this embodiment, it is preferred that the first vent comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.765 mm (0.030 inches), more preferably from about 0.125 mm (0.005 inches) to about 0.510 mm (0.020 inches). It is preferred that the second vent is located in the upper mold and comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.380 mm (0.015 inches), more preferably from about 0.076 mm (0.003 inches) to about 0.255 mm (0.010 inches).
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BRIEF DESCRIPTION OF THE DRAWING

Embodiments of the present invention will be described with reference to the accompanying drawings, in which:

- Figure 1 illustrates a cross-section of a prior art clam-shell mold;
- Figure 2 illustrates a sectional view of an article produced in the prior art mold of Figure 1;
- Figure 3 illustrates a cross-section of a vent assembly;
- Figure 4 illustrates a partial section taken along line 4-4 in Figure 3;
- Figure 5 illustrates the vent assembly of Figure 3 in a cleaning position;
- Figure 6 illustrates a cross-section of a clam-shell mold employing the vent assemblies shown in Figure 3;
- Figure 7 illustrates a perspective view of another clam-shell mold;
- Figure 8 illustrates a section taken along line 8-8 when the mold of Figure 7 is closed;
- Figure 9 illustrates a molded article made in the mold shown in Figure 7; and
- Figure 10 illustrates a cross-section of a mold employing the vent assemblies shown in Figure 3 and the vents shown in Figure 7.

BEST MODE FOR CARRYING OUT THE INVENTION

The most preferred liquid foamable polymeric composition is based upon polyurethane. However it will be apparent to those of skill in the art that the present invention is applicable to other types of molding operations including, but not limited to, latex foam, neoprene foam, PVC foams and the like.

A prior art mold will first be discussed, with reference to Figures 1 and 2. A typical clam-shell mold, similar to those used for forming an automotive seat cushion from polyurethane foam, is indicated generally at 20 in Figure 1. The mold includes a lower mold 24 and an upper mold 28 which are joined by a conventional hinge means (not shown). Lower mold 24 and upper mold 28, when closed, define a cavity 32 which corresponds to the shape of the automotive seat cushion.

In use, upper mold 28 is released from lower mold 24 and a pre-determined amount of liquid foamable polyurethane composition is dispensed into lower mold 24. Upper mold 28 and lower mold 24 are then sealingly engaged and the liquid foamable polyurethane composition expands, displacing the air within cavity 32. This displaced air exits cavity 32 through a part-line 36 and through one or more vent passages 38 in upper mold 28. Further, as the polyurethane composition expands, polymerization occurs along with the evolution of gaseous CO₂ in cavity 32. This gaseous CO₂ may also exit cavity 32 through part-line 36 and through vent passages 38. As is well known to those of skill in the art (and beyond the scope of this discussion), the liquid foamable polymeric composition eventually completely polymerizes and cures, acquiring the shape of cavity 32.

As is also known to those of skill in the art, the amount of liquid foamable polyurethane composition dispensed in cavity 32 must be selected to ensure that cavity 32 will be substantially completely filled, in order to avoid the occurrence of voids and other foaming defects in the molded article. While the determination of the proper amount of liquid foamable polyurethane composition for a particular mold may generally be calculated, as explained below it has heretofore been required to dispense an excess amount of polymeric composition into the mold to compensate for material which moves through and exits part-line 36 and vent passages 38. This excess, while assisting in ensuring that cavity 32 is filled to avoid the occurrence of voids and other foaming defects in the molded articles, is in fact simply a wastage of valuable raw material.

In prior art molds, during the molding operation, air and the reaction gases produced from the expanding composition exit from cavity 32 through part-line 36 and vent passages 38 until the foam reaches the level of their respective entrances.

At this point, any further expansion of the foam results in movement of the foam into the part-line 36 and/or vent passages 38. In the simplest case of a cav-

ity without irregularities, the foam reaches the level of the part-line and/or the vent passages at approximately the same time, which usually occurs at or near the maximum expansion point of the foam. Thus, provided that the proper amount of liquid foamable polyurethane composition has been dispensed into the cavity, only a small amount of foam enters the part-line and/or the vent passages as cavity 32 is completely filled.

In practice, however, as shown in Figure 1, most molds include irregularities in their cavities for various features required on the molded article. In such a case, the thickness and shape of mold cavity 32 typically varies across the cavity and the entrance to part-line 36 and vent passages 38 in the mold may thus be located at different heights depending upon where they communicate with cavity 32. Further, localized areas of high and low pressure also occur within cavity 32 due to the manner in which the foam and the gases produced collect in and move between the irregularities therein and thus the level of foam in different parts of cavity 32 at different times may vary.

Due to the above-mentioned factors, the foam in the cavity typically reaches the level of the part-line and/or different vent passages at different times while the foam is still expanding. For example, in a region wherein the top of cavity 32 is lower than surrounding regions, such as indicated at 40 in Figure 1, the foam may quickly reach the vent passages 38. As the foam is still rising in the rest of cavity 32 and has not yet cured, a relatively significant amount of foam may enter vent passages 38 in this region.

Again, as the amount of foam which enters the part-line 36 and vent passages 38 reduces the amount of foam remaining in cavity 32 by a like amount, it is necessary that the amount of liquid foamable polyurethane composition placed in cavity 32 include an amount in excess of that required to fill cavity 32 to offset the foam which entered the part-line and vents. This excess amount, while necessary for proper operation of the prior art mold, is essentially wasted material and adds to the cost of forming the article.

Further, as shown in Figure 2, the foam which enters vents 38 forms 'mushrooms' 54 (shown in ghosted line) of wasted material on the molded article 50. Further, the material which enters part-line 36 forms 'pancakes' 55 of wasted material on the moulded article 50. Typically, mushrooms 54 and pancakes 55 must be disconnected from article 50 and removed from the mold 20 prior to application of a finish cover to ensure a finished covered article which is of acceptable appearance and texture, and to prepare mold 20 for re-use. The necessity of removing mushrooms 54 and pancakes 55 results in an increased labour cost associated with manufacturing the molded product.

In addition to the excess liquid foamable polyurethane composition which is added to offset the material extruded into the vents, excess liquid foamable polyurethane composition is also added to compensate for process variations due to changes in temperature,

humidity, ambient pressure and minor changes in the composition of the liquid foamable polyurethane composition. Accordingly, in prior art molds, the wastage of material exiting the vents is inevitable.

Embodiments of the present invention will now be described, with reference to Figure 3 through 10.

The present inventors have determined that it is possible to use the difference in the physical characteristics of the expanding liquid foamable polymeric composition, prior to curing thereof, and the vented gases to design vents which minimize the amount of material which is extruded into the vent passages as wasted material. Specifically, it has been determined that vents may be designed with sizes which provide much different flow rates depending on the viscosity of the fluid flowing therethrough. Thus, gases, which possess a relatively low viscosity, flow relatively easily and quickly through the vent. In contrast, the liquid foamable polymeric composition, which possesses a relatively high viscosity (especially when it reaches the vent as expansion and curing are near completion), flows much more slowly through the vent due to the restriction the thickness of the vent presents to the foam.

As described hereinafter, the size of the vents is selected such that the gases in the mold may flow through the vents in a relatively unhindered manner while the viscosity of liquid foamable polymeric composition, when it reaches the vent, is such that it flows into and through the vents in a very slow manner, at best. Provided that the vent sizes are properly selected, the liquid foamable polymeric composition will have cured before it has flowed a significant distance into the vent.

As will be apparent to those of skill in the art, vents in accordance with the present invention thus reduce the amount of excess liquid foamable polymeric composition which must be dispensed in the mold to offset the material extruded into the vents.

Figures 3, 4, 5 and 6 illustrate a first embodiment of an improved vent assembly 98 in accordance with the present invention which is preferred for use in an upper mold. The vent assembly comprises a mold sleeve 100 with a guide bushing 125 with a cylindrical bore 104 therethrough. A relief pin 108 is located within and engages the inner surface of bore 104. Relief pin 108 is octagonal in cross-section, as best seen in Figure 4, and when located within guide bushing 125 defines eight vent passages 112 which are segment shaped.

The upstream end 120 of relief pin 108 which communicates with the cavity of a mold is preferably tapered and the downstream end includes a narrowed throat 124. As shown in Figure 3, when relief pin 108 is in the venting position, the downstream end of vent passages 112 are in communication with vent chamber 127 which is in turn in communication with vent outlets 128. Vent outlets 128 exhaust gases to the environment outside the mold. In the operating position shown in Figure 3, gases to be vented from a mold cavity travel along vent passages 112 to vent chamber 127 and then exit through vent outlets 128.

The dimensions of vent passages 112 are selected to allow gases to relatively freely exit cavity 202 and to restrict movement of foam within vent passages 112. Specifically, due to the relatively high viscosity of the foam, the thickness 116 of vent passages 112 present a restriction to the foam while not restricting the gases. Provided that thickness 116 is properly selected, the width 119 of vent passage 112 is not particularly limited, nor is the shape of the passage 112.

5 As will be apparent to those of skill in the art, the diameter of cylindrical bore 104 and cross-sectional shape of relief pin 108 may be varied to provide different total vent areas while maintaining the desired vent thickness. For example, relief pins with between four and eight sides, defining a like number of vent passages, have been successfully tested.

10 For polyurethane foams, it has been found that a vent passage thickness of less than about 0.255 mm (0.010 inches) presents a suitable restriction.

15 It will be understood by those of skill in the art that the thickness of the vent passage(s) may be varied according to the particular liquid foamable polymeric composition being used. Thus, if a polymer other than polyurethane is being foamed, the thickness may be suitably determined as would be apparent to those of skill in the art through empirical calculations and/or testing.

20 While vent assembly 98 has been found to be very successful at limiting foam extrusion from the mold, a small amount of foam does enter vent passages 112. Thus, it is necessary to clean vent passages 112 prior to re-use of the mold. Accordingly, the downstream end of relief pin 108 is connected to a piston 136 in a pneumatic cylinder 140. By varying the pressure on either side of piston 136 through apertures 148 or 152, the end of relief pin 108 may be extended or retracted within bore 104. As relief pin 108 is extended from vent bore 104, the downstream edge of throat 124 sweeps the interior of vent bore 104, removing residual extruded foam. As will be understood by those of skill in the art, guide bushing 125 may be fabricated from Delrin or any other suitable material. Figure 5 illustrates relief pin 108 in its extended position and Figure 3 illustrates relief pin 108 in its operating position.

25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 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7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 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9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915

amount of excess liquid foamable polymeric composition required to accommodate the foam extruded into the mold vents. Accordingly, the amount of material which enters vent assemblies 98 is reduced when compared to that obtained from conventional mold vents. This results in materials savings and may also results in labour savings since this material need not always be removed from the article or the mold.

Another embodiment of the present invention, will now be described with reference to Figures 7, 8 and 9 which is particularly preferred for use in the part-line between the upper and lower molds. A clam-shell mold is indicated generally at 400 in Figure 7. The mold includes a lower mold 404 and an upper mold 408 which define a mold cavity 412. The mold includes a series of ribbon vents 416 in accordance with the present invention. As shown in Figure 8, when mold 400 is closed, ribbon vents 416 extend between mold cavity 412 and the exterior of mold 400. It has been found that ribbon vents with a thickness indicated at 418, of about 0.125 mm (0.005 inches) to about 0.380 mm (0.015 inches) are particularly suited for use when molding polyurethane foams. As with vent passages 112 of the previous embodiment, when used with other polymeric foamable compositions, thickness 418 may be altered as required.

The width, indicated at 417, of ribbon vents 416 is not particularly limited. Widths of up to about 15 cm (6.0 inches) have been found to work in a satisfactory manner. In practice, it is contemplated that the limits to vent width 417 will primarily relate to physical limitations imposed by the shape of the article being molded and the requirement to provide an adequate total venting area to cavity 412.

In use, liquid foamable polyurethane composition is dispensed into mold cavity 412, and upper mold 408 and lower mold 404 are sealingly engaged. The air in mold cavity 412 and the gases produced by the chemical reaction occurring in the expanding composition are vented through ribbon vents 416. The viscosity of these gases are such that they flow relatively easily through ribbon vents 416. Once the level of foam in mold 400 reaches the entrance to ribbon vents 416, the foam enters ribbon vents 416. Due to the above-mentioned restriction, which is presented to the expanding composition by vent 416, the expanding composition can only move slowly through ribbon vents 416. Provided that the thickness of ribbon vents 416 has been properly selected, the liquid foamable polymeric composition will stop moving therein before it travels a significant distance along the vents and certainly before it reaches the end of ribbon vents 416.

Figure 9 illustrates an article 420 fabricated in the mold of Figure 7 employing ribbon vents 416 in accordance with the present invention. As illustrated, article 420 includes a number of ribbons 424 of extruded material from ribbon vents 416.

The advantages provided by ribbon vents 416 are many. First, the amount of material extruded into ribbon

vents 416 is limited due to the restriction presented by thickness 418 to the foam, thus the amount of raw material wasted is reduced with a resultant economic saving. Second, ribbon vents 416 are relatively inexpensive to manufacture compared to the prior art vents. Third, ribbon vents 416 may be added readily at regular spaced intervals about mold cavity 412, limited only by the shape of cavity 412, doing away with much of the iterative design effort on behalf of the mold designer and production engineers which was previously required.

Fourth, ribbon vents 416 are easy to clean and in many circumstances are self-cleaning with ribbons 424 being removed from vents 416 when the article 420 produced is removed. Fifth, ribbons 424 of extruded material produced by the ribbon vents 424 have a preferred, 'friendly' shape. Specifically, when ribbon vents 416 with relatively small thickness 418 are employed, the resulting ribbons 424 of extruded material may simply be folded back against article 420 when the finish cover is applied to it while maintaining an acceptable appearance and texture. An example of such folded back ribbons is indicated at 424a. This obviates the need to remove the ribbons 424 of extruded material and results in a labour savings.

In some circumstances, it is contemplated that it may be desirable to sandblast or otherwise roughen the inner surfaces of ribbon vents 416 to further decrease the rate at which the liquid foamable polymeric composition moves through the vent. Also, it is contemplated that in some circumstances ribbon vents with a thickness of less than 0.050 mm (0.002 inches) may be employed and that such vents will inhibit substantially all foam extrusion into the vent. In this manner, the vent acts as a differential vent allowing passage of gas but inhibiting passage of foam. However, care must be taken when using such differential vents to ensure that an adequate total venting area is still provided to avoid defects in the molded article.

It is contemplated that in many circumstances, it will be desired to employ both of the above-described embodiments in a single mold. Specifically, as shown in Figure 10, a mold 600 may include one or more otherwise isolated regions 620 at which vent assemblies 98 may preferably be employed, while ribbon vents 416 are preferably employed at the part-line of the mold. Due to their isolation from ribbon vents 416 at the part-line of the mold, vent assemblies 98 are employed to ensure that gases which would otherwise be trapped in regions 620 are properly vented. The design of such a mold, will be clearly understood by those of skill in the art, in view of the description above.

As will also be understood by those of skill in the art, further variations are possible without departing from the scope of the invention disclosed herein.

Claims

1. A method of producing an article (420) in a mold (400) comprising an upper mold (408) and a lower

mold (404) defining a mold cavity (412) the process comprising the steps of:

dispensing a liquid foamable polymeric composition into the mold cavity (412);
 allowing the liquid foamable polymeric composition to expand to substantially fill the mold cavity (412); and
 venting gases in the mold cavity (412) through at least one vent (416) in the mold (400) to allow the gases to exit from the mold (400), the size of each vent (416) being selected such that movement of the liquid foamable polymeric composition into the vent (416) is restricted to substantially prevent exit thereof from the vent (416).

2. The method of claim 1, wherein said at least one vent (416) is located at the part-line between said upper mold (408) and said lower mold (404).

3. The method of any of the preceding claims, wherein the size of each vent (416) comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.765 mm (0.030 inches).

4. The method of any of the preceding claims, wherein each vent (416) is substantially rectangular in cross-section and said liquid foamable polymeric material entering said vent (416) results in a ribbon (424) of polymeric material attached to said article.

5. The method of claim 4, further comprising the steps of folding back said ribbon (424a) of polymeric material against said article and applying a finish cover to said article.

6. The method of claim 1, wherein said at least one vent (98) is located in said upper mold (204) and is segmental in cross-section.

7. The method of claim 6, wherein the size of each vent comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.380 mm (0.015 inches).

8. A mold (400) for producing foam articles, the mold comprising:

an upper mold (408) and a lower mold (404) which define a mold cavity (412); and at least one vent (416) in communication with the mold cavity (412);

characterized in that the at least one vent (416) has a size which: (i) permits entry into the at least one vent (416) of a liquid foamable polymeric composition, and (ii) prevents exit from the at least one vent (416) of the liquid foamable polymeric composition.

9. A mold according to claim 8, further including at least first (416) and second (98) vents in communication with said mold cavity, said first vent being located at the part-line between said upper mold and said lower mold.

5 10. A mold according to claim 9, wherein the size of said first vent (416) comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.765 mm (0.030 inches).

11. A mold according to claim 9 or claim 10, wherein said second vent (98) is located in said upper mold.

15 12. A mold according to claim 11, wherein said second vent comprises a thickness of from about 0.050 mm (0.002 inches) to about 0.380 mm (0.015 inches).

20 13. A mold according to claim 11 or claim 12, wherein said second vent (98) is segmental in cross-section.

25 14. A mold according to any of claims 9-13, wherein said second vent (98) comprises a passageway and an obstruction (108) in said passageway, said obstruction and said passageway combining to form an opening (112) having a shape capable of restricting the movement of liquid foamable polymeric composition in the vent (98).

30 15. A mold according to any of claims 9-13, wherein said second vent (98) comprises a passageway and an obstruction (108) combining to form a plurality of openings (112) between the obstruction (108) and a wall (125) of said passageway, said openings (112) having a shape capable of restricting the movement of liquid foamable polymeric composition in the vent (98).

35 40 16. A mold according to claim 14 or claim 15, wherein said obstruction (108) is movable axially with said passageway to expel any polymeric composition present in said passageway.

45 Patentansprüche

1. Verfahren zum Herstellen eines Gegenstandes (420) in einer Form (400) mit einem oberen Formteil (408) und einem unteren Formteil (404), die ein Formnest (412) bilden, wobei das Verfahren die folgenden Schritte umfaßt:

50 55 Einführen einer flüssigen, schäumbaren polymeren Verbindung in das Formnest (412)
 Expandieren lassen der flüssigen, schäumbaren polymeren Verbindung bis diese das Formnest 412 im wesentlichen ausfüllt; und
 Entlüften von Gasen im Formnest (412) durch wenigstens eine Öffnung (416) in der Form

(400), um die Gase aus der Form 400 zu entla-
sten, wobei die Größe der Öffnung (416) derart
bemessen ist, daß die Bewegung der flüssi-
gen, schäumbaren polymeren Verbindung in
die Öffnung (416) beschränkt ist, um deren
Austritt durch die Öffnung (416) im wesentli-
chen zu vermeiden. 5

2. Verfahren nach Anspruch 1, dadurch gekennzeich-
net, daß wenigstens eine Öffnung (416) an der
Trennlinie zwischen dem oberen und dem unteren
Formteil (408, 404) angeordnet ist. 10

3. Verfahren nach einem der vorausgegangenen
Ansprüche, dadurch gekennzeichnet, daß die
Größe einer jeden Öffnung (416) eine Stärke von
etwa 0,050 mm (0,002 Zoll) bis etwa 0,765 mm
(0,030 Zoll) beträgt. 15

4. Verfahren nach einem der vorausgegangenen
Ansprüche, dadurch gekennzeichnet, daß jede Öff-
nung (416) im wesentlichen von rechteckigem
Querschnitt ist, und daß das genannte flüssige
schäumbare polymere Material, das in die
genannte Öffnung (416) eintritt, ein Band (424) aus
polymerem Material ergibt, das an dem genannten
Gegenstand befestigt ist. 20

5. Verfahren nach Anspruch 4, weiterhin umfassend
den Schritt des Umfaltens des genannten Bandes
(424a) aus polymerem Material gegen den genann-
ten Gegenstand und des Aufbringens einer Finnis-
hing-Decke auf den genannten Gegenstand. 25

6. Verfahren nach Anspruch 1, dadurch gekennzeich-
net, daß wenigstens eine Öffnung (98) im oberen
Formteil (204) angeordnet und im Querschnitt seg-
mentartig ist. 30

7. Verfahren nach Anspruch 6, dadurch gekennzeich-
net, daß die Größe einer jeden Öffnung eine Stärke
von etwa 0,05 mm (0,002 Zoll) bis etwa 0,380 mm
(0,015 Zoll) beträgt. 35

8. Form (400) zum Herstellen von Gegenständen, 40
umfassend :

ein oberes Formteile (408) und ein unteres Form-
teil (404), die ein Formnest (412) bilden; und
wenigstens eine Öffnung (416) in leitender Ver-
bindung mit dem Formnest (412); 45

dadurch gekennzeichnet, daß wenigstens eine Öff-
nung (416) eine Größe aufweist, die (i) den Eintritt
einer flüssigen, schäumbaren polymeren Verbin-
dung in wenigstens eine Öffnung (416) erlaubt; (ii)
den Austritt der flüssigen, schäumbaren polymeren
Verbindung aus wenigstens einer Öffnung (416)
verhindert. 50

9. Form nach Anspruch 8, weiterhin umfassend
wenigstens erste (416) und zweite (98) Öffnungen in
leitender Verbindung mit dem Formnest, wobei die
erste Öffnung an der Trennlinie zwischen dem obe-
ren und dem unteren Formteil angeordnet ist. 5

10. Form nach Anspruch 9, wobei die Größe der ersten
Öffnung (416) eine Stärke von etwa 0,050 mm
(0,002 Zoll) bis etwa 0,765 mm (0,030 Zoll) auf-
weist. 10

11. Form nach Anspruch 9 oder 10, wobei die
genannte zweite Öffnung (98) dem oberen Formteil
angeordnet ist. 15

12. Form nach Anspruch 11, wobei die zweite Öffnung
eine Stärke von etwa 0,050 mm (0,002 Zoll) bis
etwa 0,380 mm (0,015 Zoll) aufweist. 20

13. Form nach Anspruch 11 oder 12, wobei die zweite
Öffnung (98) im Querschnitt segmentartig ist. 25

14. Form nach einem der Ansprüche 9 bis 13, wobei
die zweite Öffnung (98) einen Kanal sowie ein Ver-
schlußorgan im Kanal aufweist, wobei der Ver-
schluß und der Kanal gemeinsam eine Öffnung
(112) miteinander bilden, die eine solche Gestalt
aufweist, daß sie in der Lage ist, die Bewegung
schließfähiger schäumbarer polymerer Verbindung
in der Öffnung (98) zu begrenzen. 30

15. Form nach einem der Ansprüche 9 bis 13, wobei
die genannte zweite Öffnung einen Kanal sowie ein
Verschlußorgan (108) aufweist, die gemeinsam
eine Mehrzahl von Öffnungen (112) zwischen dem
Verschluß (108) und einer Wand (125) des genann-
ten Kanals bilden, und wobei die Öffnung (112)
eine solche Gestalt hat, daß sie in der Lage ist, die
Bewegung flüssiger schäumbarer polymerer Ver-
bindungen in der Öffnung (98) zu begrenzen. 35

16. Form nach Anspruch 14 oder 15, wobei das
genannte Verschlußorgan (108) axial im Kanal
beweglich ist, um jegliche polymere Verbindung,
die im Kanal vorhanden ist, auszustoßen. 40

Revendications

1. Un procédé de fabrication d'un article (420) dans
un moule (400) comprenant un moule supérieur
(408) et un moule inférieur (404) définissant une
cavité de moulage (412), le processus comprenant
les étapes consistant :
 - à distribuer une composition polymère liquide
moussante dans la cavité de moulage (412);
 - à permettre à la composition polymère liquide
moussante de se dilater pour remplir sensiblement
la cavité de moulage (412); et

- à évacuer les gaz présents dans la cavité de moulage (412) à travers au moins un évent (416) dans le moule (400), pour permettre aux gaz de s'échapper du moule (400), la taille de chaque évent (416) étant choisie de telle façon que le déplacement de la composition polymère liquide moussante dans l'évent (416) soit limité pour empêcher sensiblement la sortie de la composition hors de l'évent (416).

2. Le procédé selon la revendication 1, dans lequel ledit au moins un évent (416) est disposé dans le plan de joint entre ledit moule supérieur (408) et ledit moule inférieur (404).

3. Le procédé selon l'une quelconque des revendications précédentes, dans lequel la taille de chaque évent (416) se caractérise par une épaisseur d'environ 0,050 mm (0,002 pouce) à environ 0,765 mm (0,030 pouce).

4. Le procédé selon l'une quelconque des revendications précédentes, dans lequel chaque évent (416) présente une section transversale sensiblement rectangulaire et ledit matériau polymère liquide moussant pénétrant dans ledit évent (416) se transforme en un ruban (424) de matériau polymère fixé audit article.

5. Le procédé selon la revendication 4, comprenant en outre les étapes consistant à replier ledit ruban (424a) de matériau polymère contre ledit article et à appliquer un recouvrement de finition audit article.

6. Le procédé selon la revendication 1, dans lequel ledit au moins un évent (98) est situé dans ledit moule supérieur (204) et présente une section transversale segmentée.

7. Le procédé selon la revendication 6, dans lequel la taille de chaque évent se caractérise par une épaisseur d'environ 0,050 mm (0,002 pouce) à environ 0,380 mm (0,015 pouce).

8. Un moule (400) pour fabriquer des articles alvéolaires, le moule comprenant :

- un moule supérieur (408) et un moule inférieur (404) qui définissent une cavité de moulage (412); et
- au moins un évent (416) en communication avec la cavité de moulage (412);

caractérisé en ce que le au moins un évent (41) présente une taille qui :

(i) permet l'entrée dans le au moins un évent (416) d'une composition polymère liquide moussante, et

(ii) empêche la sortie hors du au moins un évent (416) de la composition polymère liquide moussante.

5. 9. Un moule selon la revendication 8, comprenant en outre au moins des premier (416) et deuxième (98) événets en communication avec ladite cavité de moulage, ledit premier évent étant disposé dans le plan de joint entre ledit moule supérieur et ledit moule inférieur.

10. Un moule selon la revendication 9, dans lequel la taille dudit premier évent (416) se caractérise par une épaisseur d'environ 0,050 mm (0,002 pouce) à environ 0,765 mm (0,030 pouce).

15. 11. Un moule selon la revendication 9 ou la revendication 10, dans lequel ledit deuxième évent (98) est situé dans ledit moule supérieur.

20. 12. Un moule selon la revendication 11, dans lequel ledit deuxième évent se caractérise par une épaisseur d'environ 0,050 mm (0,002 pouce) à environ 0,380 mm (0,015 pouce).

25. 13. Un moule selon la revendication 11 ou la revendication 12, dans lequel ledit deuxième évent (98) présente une section transversale segmentée.

30. 14. une moule selon l'une quelconque des revendications 9 à 13, dans lequel ledit deuxième évent (98) comporte un passage et une obstruction (108) dans ledit passage, ladite obstruction et ledit passage se combinant pour former une ouverture (112) présentant une forme capable de restreindre le déplacement de la composition polymère liquide moussante dans l'évent (98).

35. 15. Un moule selon l'une quelconque des revendications 9 à 13, dans lequel ledit deuxième évent (98) comporte un passage et une obstruction (108) se combinant pour former une pluralité d'ouvertures (112) entre l'obstruction (108) et une paroi (125) dudit passage, ladite ouverture (112) présentant une forme capable de restreindre le déplacement de la composition polymère liquide moussante dans l'évent (98).

40. 16. Un moule selon la revendication 14 ou la revendication 15, dans lequel ladite obstruction (108) est susceptible de se déplacer axialement avec ledit passage pour expulser une composition polymère quelconque présente dans ledit passage.

45. 55.

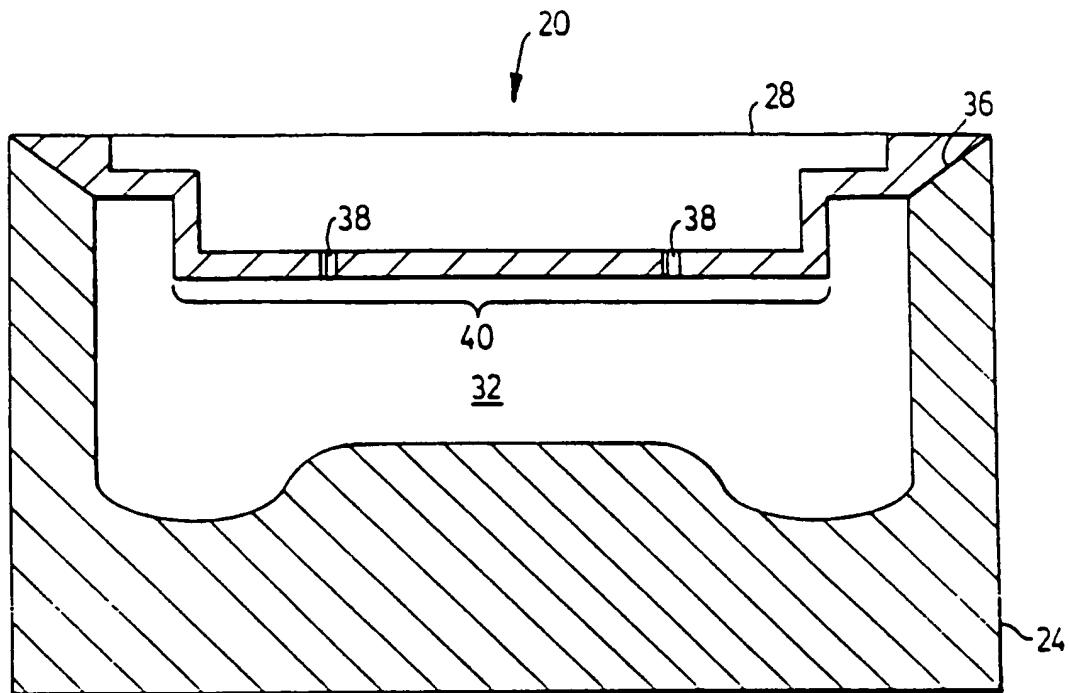


FIG.1

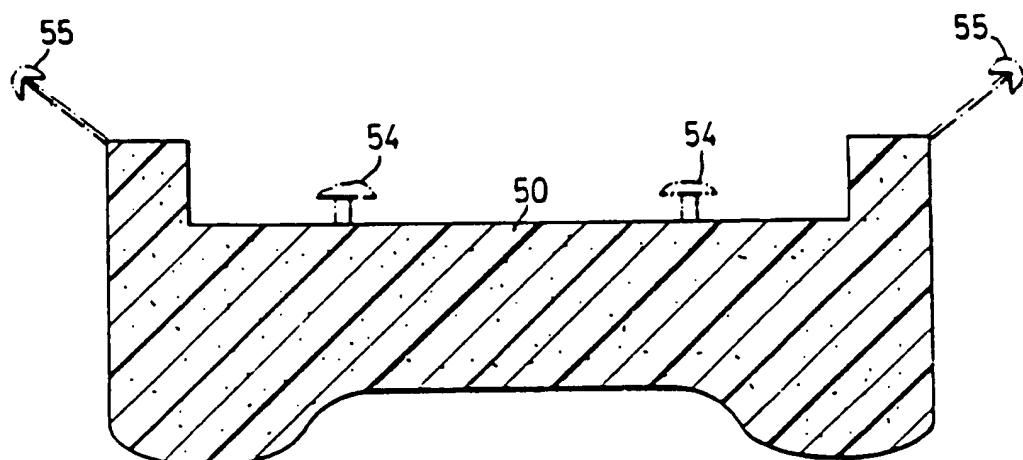
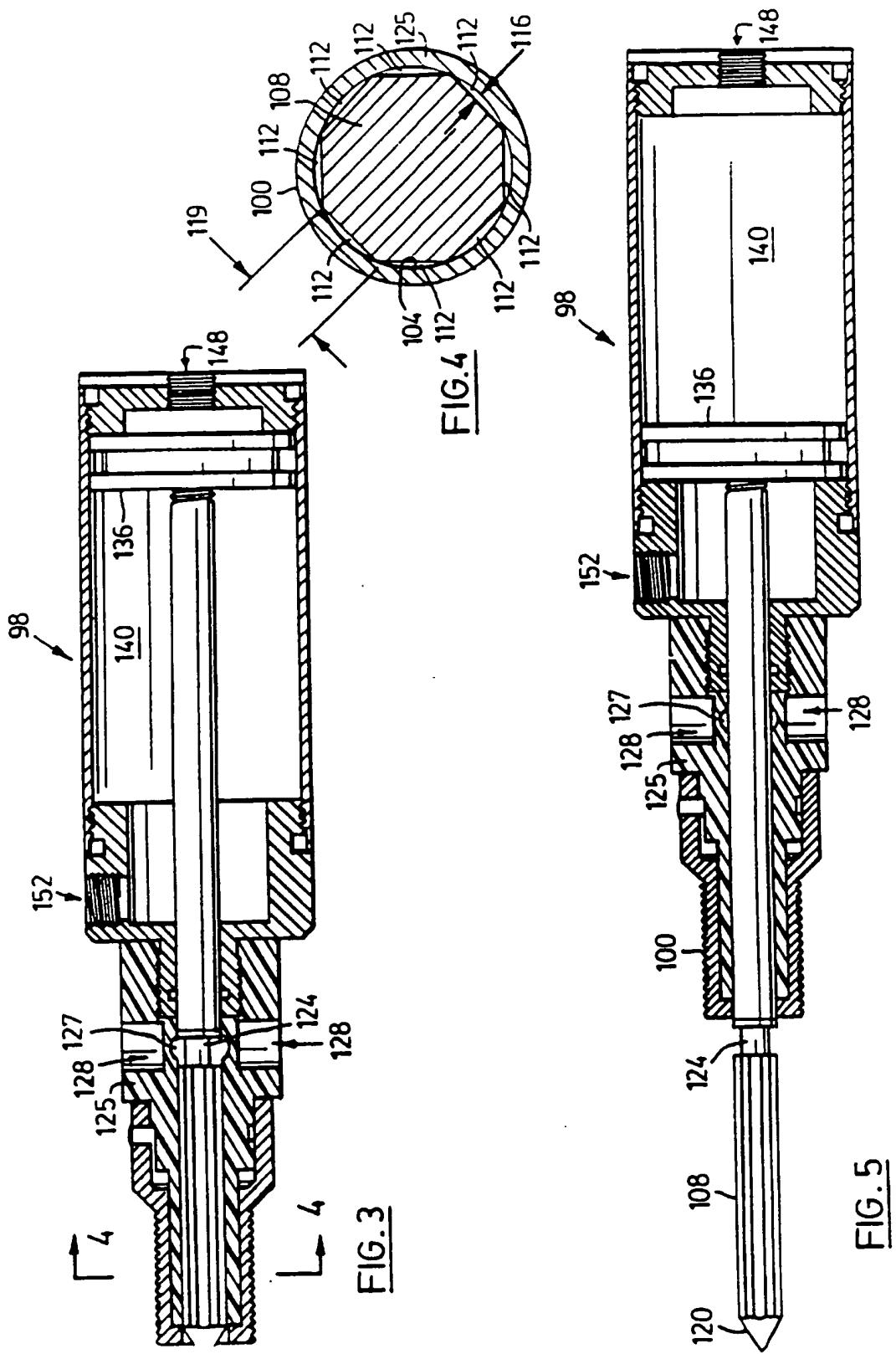


FIG.2



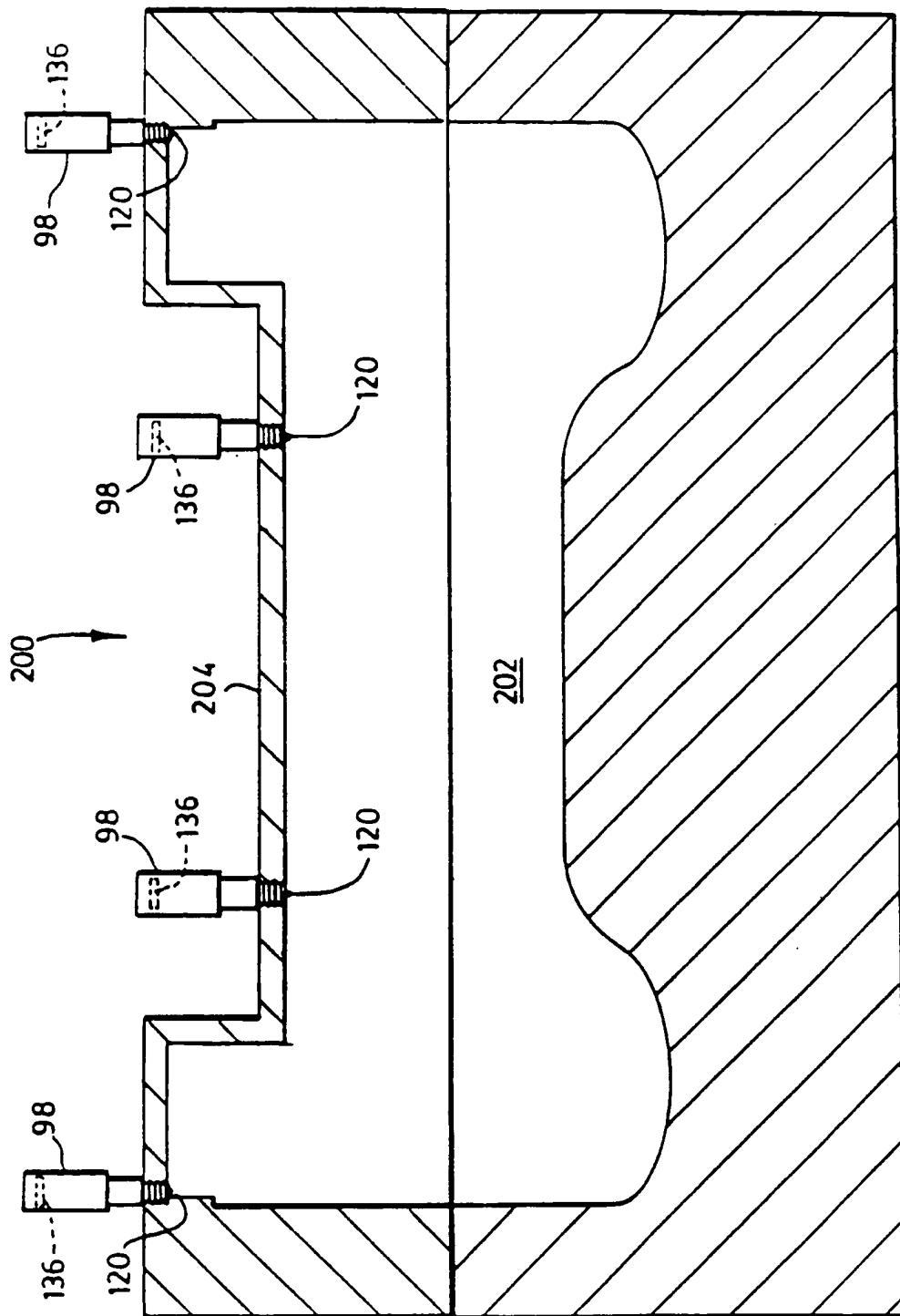
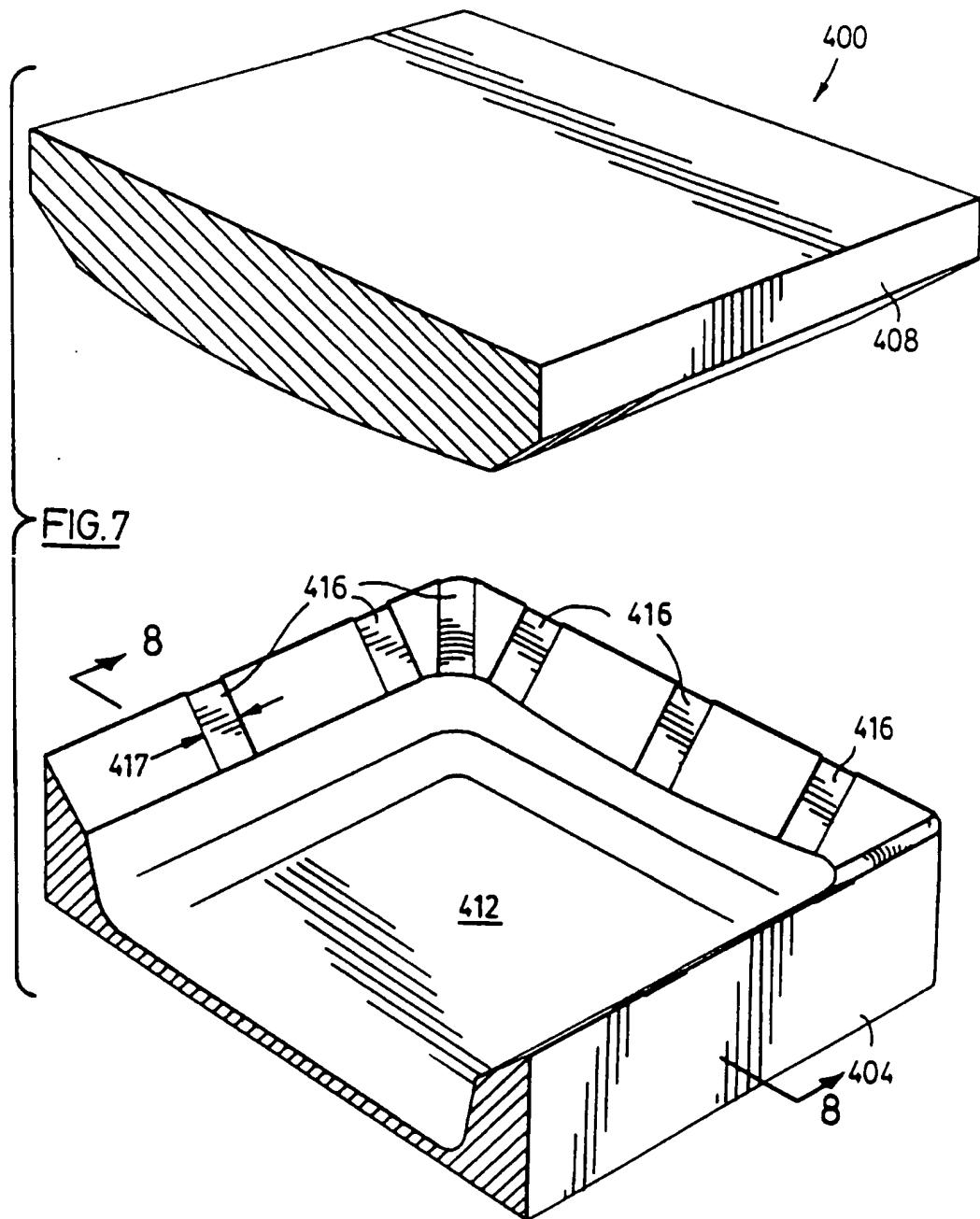


FIG. 6



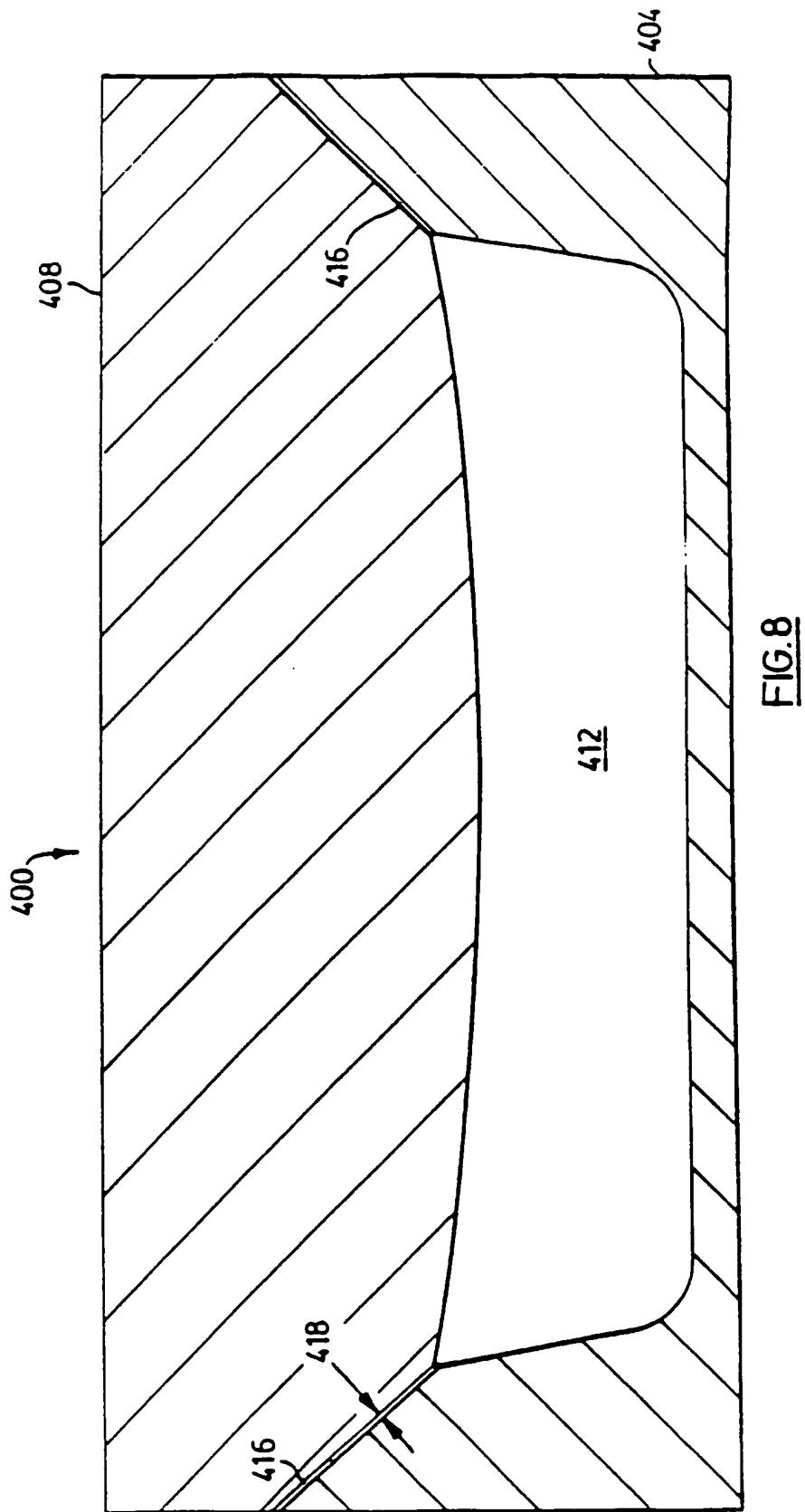


FIG. 8

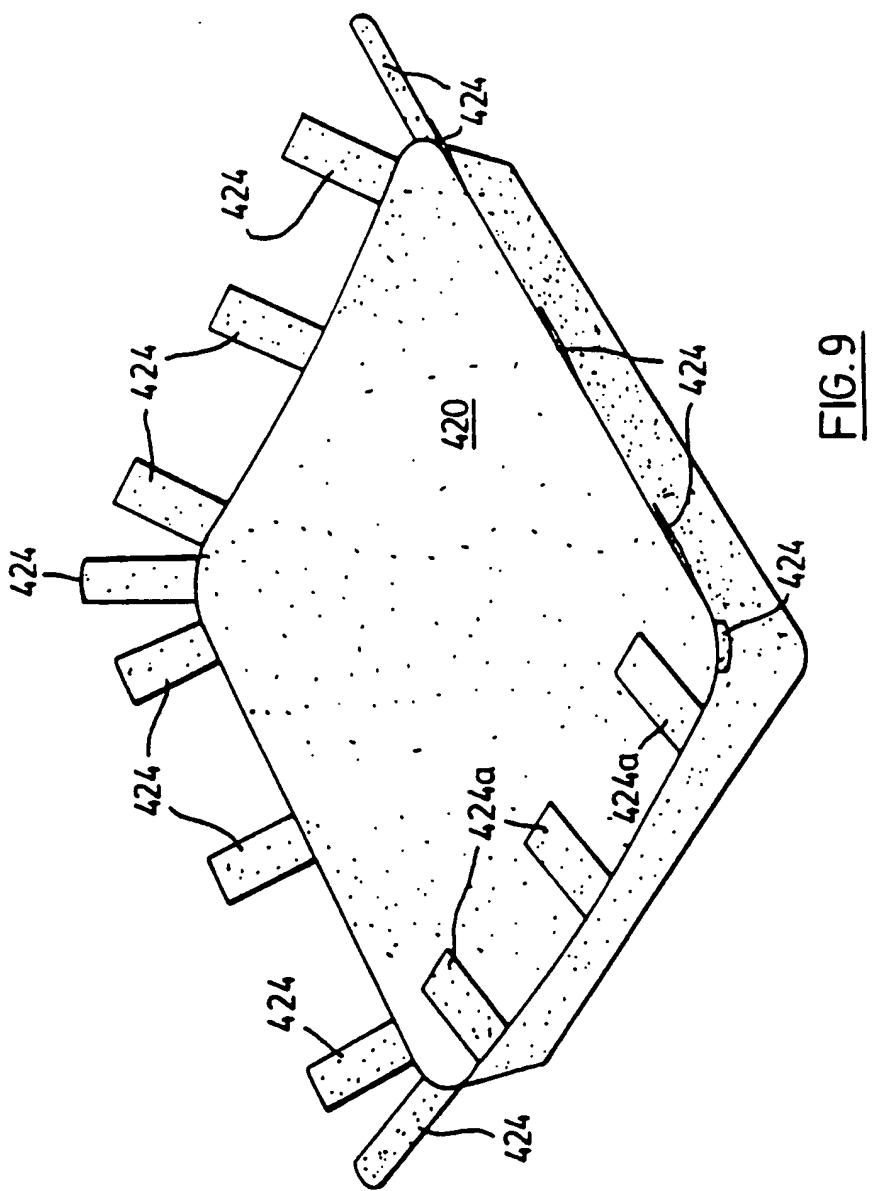
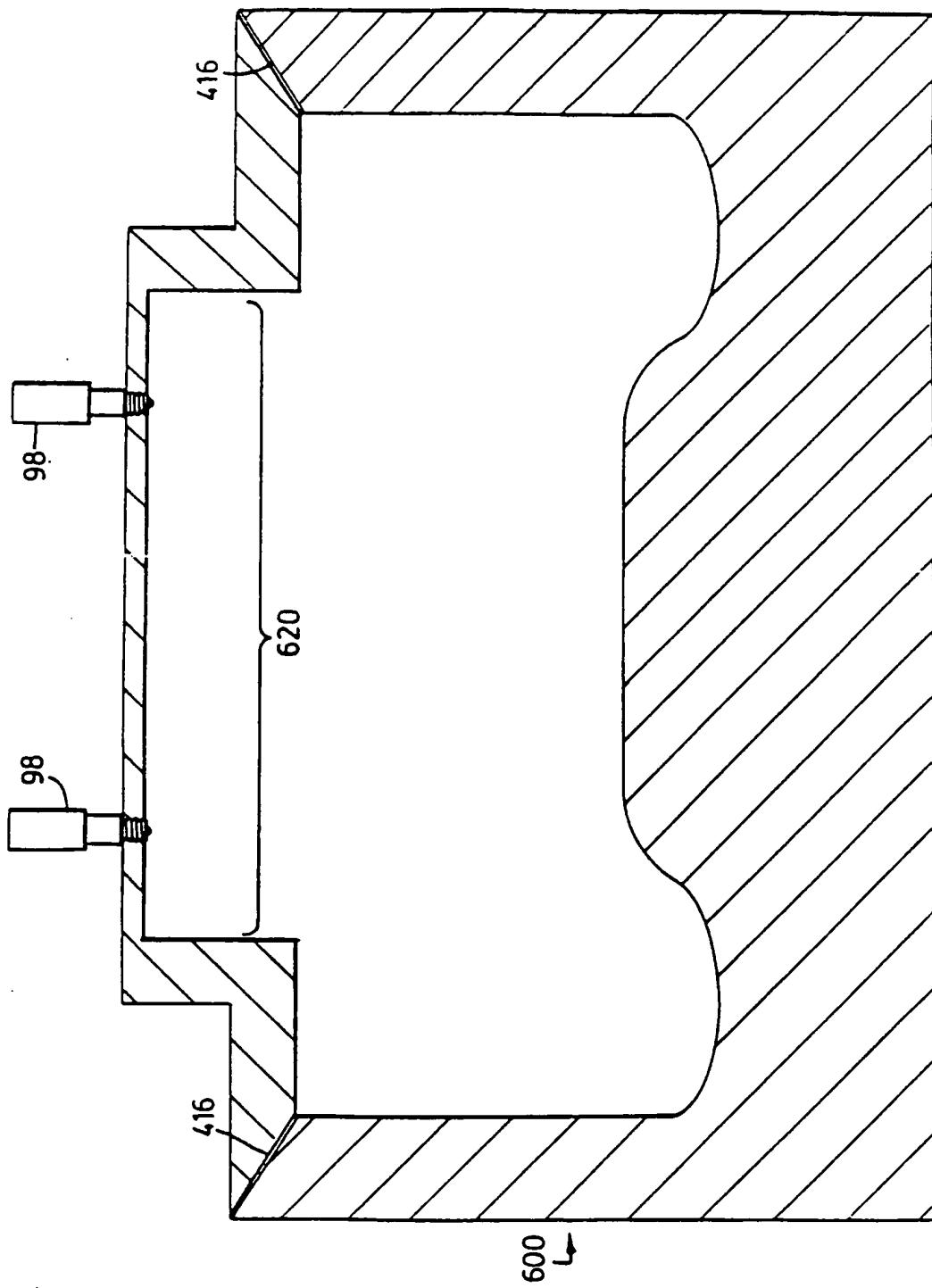


FIG.10



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